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ABSTRACT

The United States Training and Employment Service General Aptitude Test Battery (GATB), first published in 1947, has been included in a continuing program of research to validate the tests against success in many different occupations. The GATB consists of 12 tests which measure nine aptitudes: General Learning Ability; Verbal Aptitude; Numerical Aptitude; Spatial Aptitude; Form Perception; Clerical Perception; Motor Coordination; Finger Dexterity; and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, and a standard deviation of 20. Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, when combined, predict job performance. Cutting scores are set only for those aptitudes which aid in predicting the performance of the job duties of the experimental sample. The GATB norms described are appropriate only for jobs with content similar to that shown in the job description presented in this report. A description of the validation sample is included. (AG)

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TECHNICAL REPORT

ON

STANDARDIZATION OF THE GENERAL APTITUDE TEST BATTERY

FOR

PRECISION LENS GRINDER (optical goods) 5-08.071

~~B-614~~
S-334

U. S. Employment Service in
Cooperation with
California State Employment Service

March 1965

STANDARDIZATION OF THE GENERAL APTITUDE TEST BATTERY

FOR

PRECISION LENS GRINDER (optical goods) 5-08.071

B-614

Summary

The General Aptitude Test Battery, B-1002B, was administered to a final sample of 52 individuals employed as Precision Lens Grinder 5-08.071 at various companies in California. The criterion consisted of supervisory ratings. On the basis of mean scores, standard deviations, correlations with the criterion, job analysis data and their combined selective efficiency, S-Spatial Aptitude, P-Form Perception and M-Manual Dexterity were selected for inclusion in the final test norms.

GATB Norms for Precision Lens Grinder (optical goods) 5-08.071, B-614

B-1001			B-1002		
Aptitude	Tests	Minimum Acceptable Aptitude Score	Aptitude	Tests	Minimum Acceptable Aptitude Score
S	CB-1- F CB-1- H	100	S	Part 3	95
P	CB-1- A CB-1- L	80	P	Part 5 Part 7	80
M	CB-1- M CB-1- N	75	M	Part 9 Part 10	75

Effectiveness of Norms

The data in Table IV indicate that only 67 percent of the non-test-selected workers used for this study were good workers; if the workers had been test-selected with the above norms, 80 percent would have been good workers. 33 percent of the non-test-selected workers used for this study were poor workers; if the workers had been test-selected with the above norms, only 20 percent would have been poor workers.

TECHNICAL REPORT

I. Purpose

This study was conducted to determine the best combination of aptitudes and minimum scores to be used as norms on the General Aptitude Test Battery for the occupation of Precision Lens Grinder 5-08.071.

II. Sample

During the period August 1, 1963 to October 10, 1964, the General Aptitude Test Battery, B-1002B, was administered to 53 male and 4 female Precision Lens Grinders 5-08.071 employed by several companies in California. The plant job title used by the majority of the companies to identify this job is Optical Technician. One company identified these workers as Optical Fabricators. The name and location of the participating companies are as follows:

Name	Location
Nortronics	Anaheim
Perkin-Elmer	Costa Mesa
Infrared Industries	Santa Barbara
Beckman Instrument	Fullerton
Applied Physics	Monrovia
Aerojet General Corporation	Azusa
Spectrolab Incorporated	Sylmar
Herron Optical Company	Los Angeles
Thompson Optical Engineering Co.	Los Angeles
Pacific Optical Corporation, Division of Chicago Aerial	Inglewood

The final sample consisted of 49 male and 3 female Precision Lens Grinders who were performing all phases of the job as described in the Job Description on pages 3-6 of this report.

All companies have similar hiring practices and applicant requirements. All applicants are required to prepare a standard job application form, to have an initial interview with a personnel department interviewer, and to have a final interview with a supervisor in the optics department. Applicants with a high school education and a knowledge of math are preferred. The ability to do painstaking work is helpful. On-the-job training is provided with length of training time varying between 10 to 14 months, depending upon the individual being trained.

One company, Applied Physics, administered the Wonderlic Test to all job applicants. However, it was still in the research stages and a cut-off score had not been determined for specific occupations.

TABLE II

Means (M), Standard Deviations (σ), Ranges, and Pearson Product-Moment Correlations with the Criterion (r) for Age, Education and Experience

	M	σ	Range	r
Age (years)	38.9	10.3	22-65	-.230
Education (years)	11.6	1.5	5-14	.113
Experience (months)	147.5	101.1	16-456	-.035

III. Job Description

Job Title: Precision Lens Grinder (optical goods) 5-08.071

Job Summary: Sets up and operates grinders, curve generators, and polisher and performs hand operations to fabricate precision lens, prisms, and mirrors for industrial, military, and scientific application.

Work Performed: Plans procedure: Reviews job specification and blueprint with optical shop foreman to determine the type of tools to use and amount of material needed; to develop a time schedule with allowable tolerances in sequence of operation. Determines type of glass to use, if none is specified, by considering physical characteristics of material to be used and conditions to which it will be subjected. Selects abrasives and polishing compounds which are compatible with materials used. Studies mathematical calculations of blueprint to visualize completed optical element, in order to understand work requirements and machine settings.

Saws lens blank: Checks specifications to determine quality of glass to be used. Obtains lens blank from supply room or from foreman and checks package or bin markings to insure proper selection. Inspects glass stock visually for internal strains and imperfections. Selects saw blade of proper thickness depending on quality of blank to be cut and tolerance requirements. Uses wrench to attach saw blade to spindle. Using ruler, micrometer, or graduated markings on guide, sets guide stop on carriage of diamond saw for length and angle desired, and tightens set screw to hold guide. Presses button to start circulating pump for coolant which flows on both sides of diamond saw. Places blank on carriage and pushes firmly against guide. Adjusts clamp to hold blank or holds it with hands during sawing operation. Starts saw and pushes carriage forward or presses button to engage automatic carriage feed.

Blocks lens blank: Selects block or fixture of correct weight and size from stock room to hold lens blank during grinding and polishing operations. Places block and lens blank on degreaser rack attached to

overhead hoist and lowers parts into tank of hot vaporous gases to heat and clean them. Places parts on rack to cool. Coats surface of block with adhesive, such as wax, wax-shellac compound, melted pitch, or plaster of Paris, depending upon size and weight of lens blank. Fills recesses of concave or convex lens blank with adhesive. Positions lens blank on block and presses firmly into adhesive to fasten lens blank to block. Runs cold water beneath rack to cool parts and hasten sealing. Melts adhesive in degreaser, taps edge of block sharply with wooden mallet to break seal or uses shock treatment (heating lens blank with torch and dipping block in cold water) to remove lens blank from block after each operation.

Sets up and operates grinder: Checks blueprint and mathematical calculations, using formula given on blueprint to set up machine to reduce lens blank to specification. Positions blocked lens blank on electromagnetic chuck of semi-automatic grinder and presses switch to energize magnet which holds optical element in position. Turns handfeed wheel that lowers vertical grinding wheel to highest point of lens blank. Sets grinder-control dial to tolerance specified on blueprint. Utilizes knowledge of characteristics of glass to set dial regulating speed of grinding wheel and rotating chuck when feeding lens blank into grinding wheel. Checks level of coolant in reservoir under table to insure emersion of pumping mechanism. Closes protective shield on machine and presses switches to start coolant flowing over work piece at the same time chuck starts revolving. Pulls lever to engage grinding wheel and observes downfeed pressure gage during grinding operation. Pulls lever that stops wheel if gage indicates improper pressure. When pre-set tolerance has been reached, presses reverse switch to raise grinding wheel after machine stops. Lifts protective shield. Dries work piece and chuck with air hose. Measures surface of blank with depth micrometer. Re-coats lens blank with colored crayon when measurements do not meet specifications. Makes new calculation; resets grinder and repeats grinding operation.

Sets up and operates generator: Examines blueprint to determine machine settings. Cements lens blank to generator chuck and places chuck on spindle. Turns chuck counter-clockwise to fasten chuck to generator spindle. Heats backing plate of chuck with torch to soften adhesive. Locates dial indicator against lens blank, rotates chuck by hand, and adjusts lens blank on tacky adhesive to center lens blank according to needle of dial indicator. Places centering point on generator ring spindle. Turns handwheel to adjust lens blank to correct angle and align centering point to position against edge of lens blank. Sets tolerance indicator and degree scale of generator to obtain curvature and oscillation necessary to reduce thickness of lens blank, as specified on work-order. Replaces centering point with diamond impregnated generator-wheel ring, and tightens set screw with wrench to fasten ring to spindle. Turns handfeed wheel to advance lens blank against generator wheel ring. Checks reservoir containing coolant to ascertain if supply is adequate. Presses switch to start flow of coolant, then pulls lever to start generator which stops automatically when pre-set tolerance is reached. Measures

accuracy of dimensions using such instruments as spherometer and calipers, and examines optical element with magnifying glass to detect damage, such as digs or breakdown. Follows above procedure to obtain a beveled or flat-cut edge on optical elements.

Operates fine grinder in polishing room: Visually inspects optical element under high intensity light (Burton lamp) for scratches and digs to determine grade of abrasive for use in obtaining specified surface tolerance. Selects lap of appropriate curve or flat surface. If appropriate lap is not available, makes one to specification by fastening ceramic tile, glass, or other material to metal place with plaster or pitch and placing lap in generator to obtain appropriate curve. Selects block of appropriate curve or flat surface, making allowance for adhesive (wax) between optical element and block, to obtain tolerance specified. Places optical element on dry lap with two or three drips of oil to hold element in place. Covers optical element with wax. Heats block to melting point of wax. Places lap and heated block in arbor press and closes press causing wax to melt. Removes lap and block from press when wax cools and optical element is fastened to block. Places lap on grinding machine spindle. Fits pin of grinder's traverse arm into receptor on backing plate of lens block, allowing block to pivot freely. Places cast iron weights on end of pin that extends above traverse arm to obtain pressure required to produce specified tolerance. Mixes powdered abrasive with water and applies mixture to lap with brush. Turns handwheel to set speed of lap and uses wrench to turn set screw on traverse arm to regulate length of stroke, utilizing knowledge of characteristics of optical elements and abrasives to determine pressure and oscillation speed. Brushes abrasive mixture on lap or optical element during grinding operation. Stops machine and removes all parts. Washes parts and machine thoroughly with water to prevent larger grit of abrasive from collecting around edge and scratching optical element. Replaces optical element and lap on grinding machine, reapplies abrasive, and repeats wet sequence from 3 to 5 times for each grade of abrasive used. Examines optical element under high intensity light for scratches and digs each time parts are washed.

Polishes optical elements: Applies rouge and water mixture to optical element or lap and starts polisher. Observes polishing machines during operation and uses small brush to add rouge mixture as needed. Removes optical element and lap from machine and washes parts thoroughly (wet sequence). Cleans optical element and test plate with solvent (acetone or ethylene alcohol). Removes film on optical element and test plate with tissues. Removes particles of dust from optical element and test plate with soft brush. Cleans testing area with vacumm hose. Places test plate on optical element under monochromatic light and views light fringes visible in element. Interprets light refractions in terms of surface deviation from absolute flatness to one millionth of an inch (fringe measurement). Mentally notes degree of deviation and returns element to machine for corrections. Places optical element in interferometer to obtain parallel measurements to extremely close tolerance (.000011).

Polishes optical elements such as prisms and exotic metals by hand: Places abrasive on rotating lap and holds optical element or pre-machined metal parts against lap. Cleans element and measures flat surface, using test plate. Measures angular surfaces with auto callimator. Places optical element under spectrometer for precise angular measurements to 1" or 2" of arc on angle. Repeats above procedure 3 to 5 times to obtain specified surface.

IV. Experimental Battery

All the tests of the GATB, B-1002B, were administered to the sample group.

V. Criterion

The criterion data consisted of two sets of independent ratings made by the first line supervisor at each company on an adaptation of USES Form SP-21, "Descriptive Rating Scale." A period of at least two weeks elapsed between the first and second ratings. The rating scale consisted of seven items covering different aspects of job performance, with four alternatives for each item. Weights of one through four were assigned to the alternatives so that the minimum possible total score was 7 and the maximum 28. A reliability coefficient of .95 was obtained for the criterion. Therefore the two sets of ratings were combined, resulting in a distribution of final criterion scores of 22-56, with a mean of 39.8 and a standard deviation of 10.0.

VI. Qualitative and Quantitative Analyses

A. Qualitative Analysis

On the basis of the job analysis data, the following aptitudes were rated "important" for success in this occupation:

Intelligence (G) - required to learn and understand written instructions in order to follow work order and various testing procedures; to set up machines to specification; to determine type of glass to use by considering physical characteristics of glass.

Spatial Aptitude (S) - required to be able to visualize the completed three-dimensional product.

Form Perception (P) - required to make visual discriminations in quality of glass. Surface deviations are noted by length, width, and contortion of colored lines under testing equipment; internal strains and imperfections are noted by observing any deviation from the normal physical characteristics of glass stock.

Manual Dexterity (M) - required to handle small objects, to turn knobs and to dial and manipulate tools.

B. Quantitative Analysis:

TABLE II

Means (M), Standard Deviations (σ), and Pearson Product-Moment Correlations with the Criterion (r) for the Aptitudes of the GATB; N = 52

Aptitudes	M	σ	r
G-Intelligence	103.3	15.7	.273*
V-Verbal Aptitude	101.9	12.8	.255
N-Numerical Aptitude	97.6	16.7	.225
S-Spatial Aptitude	104.1	19.3	.345*
P-Form Perception	95.3	18.0	.445**
Q-Clerical Perception	100.2	15.0	.266
K-Motor Coordination	98.7	14.8	.109
F-Finger Dexterity	91.0	19.3	.113
M-Manual Dexterity	104.2	20.1	.235

*Significant at the .05 level
**Significant at the .01 level

C. Selection of Test Norms:

TABLE III

Summary of Qualitative and Quantitative Data

Type of Evidence	Aptitudes								
	G	V	N	S	P	Q	K	F	M
Job Analysis Data									
Important	X			X	X				X
Irrelevant									
Relatively High Mean	X			X					X
Relatively Low Sigma		X					X		
Significant Correlation with Criterion	X			X	X				
Aptitudes to be Considered for Trial Norms	G			S	P				M

Trial norms consisting of various combinations of Aptitudes G, S, P, and M with appropriate cutting scores were evaluated against the criterion by means of the Phi Coefficient technique. A comparison of the results showed that B-1002 norms consisting of S-95, P-80 and M-75 had the best selective efficiency.

VII. Validity of Norms

The validity of the norms was determined by computing a Phi Coefficient between the test norms and the criterion and applying the Chi Square test. The criterion was dichotomized by placing 33 percent of the sample in the low criterion group because this percent was considered to be the unsatisfactory or marginal workers.

Table IV shows the relationship between test norms consisting of Aptitudes S, P, and M with critical scores of 95, 80, and 75, respectively, and the dichotomized criterion for Precision Lens Grinder 5-08.071. Workers in the high criterion group have been designated as "good workers" and those in the low criterion group as "poor workers".

TABLE IV

Validity of Test Norms for Precision Lens Grinder 5-08.071.
(S-95, P-80, M-75)

N = 52	Non-Qualifying Test Scores	Qualifying Test Scores	Total
Good Workers	11	24	35
Poor Workers	11	6	17
Total	22	30	52

Phi Coefficient = .316
χ^2 = 5.191
P/2 < .025

The data in the above table indicate a significant relationship between the test norms and the criterion for the sample.

VIII. Conclusions

On the basis of the results of this study, Aptitudes S, P, and M with minimum scores of 95, 80, and 75, respectively, have been established as B-1002 norms for the occupation of Precision Lens Grinder 5-08.071. The equivalent B-1001 norms consist of S-100, P-80 and M-75.

IX. Determination of Occupational Aptitude Pattern

The data for this study did not meet the requirements for incorporating the occupation studied into any of the 36 OAP's included in Section II of the Guide to the Use of the General Aptitude Test Battery, January 1962. The data for this sample will be considered for future groupings of occupations in the development of new occupational aptitude patterns.